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(71) Applicant
Graco Inc.

(Incorporated in USA—Minnesota)

P O Box 1441, Minneapolis, Minnesota 55440, United States of America

(72) Inventors
Herman Robisch
Arthur T. Kroll

(74) Agent and/or Address for Service
J. Miller & Co., Lincoln House, 296-302 High Holborn, London WC1V 7JH

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(54) Rotary spray atomizer

(57) A rotary spray atomizer for distributing atomized particles of a liquid e.g. paint, under the influence of electrostatic forces, comprises; a housing (12) of electrically non-conductive material and having an interior recess (12*a*) therein; a rotor (17) of non-conductive material rotatably mounted in the recess (12*a*); a non-conductive dish-shaped member (14) fixedly attached to said rotor (17); a non-conductive liquid feed tube (20); a non-conductive turbine (30) attached to said rotor (17); an electrode (50) for applying a high voltage to the liquid; and nozzles (38) for delivering pressurized air against said turbine member blades (31). The rotor, shaft and housing may be or ceramic material.

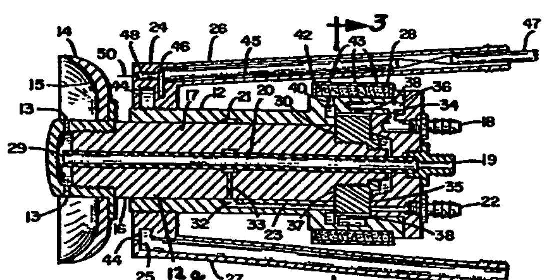

Fig. 2 3

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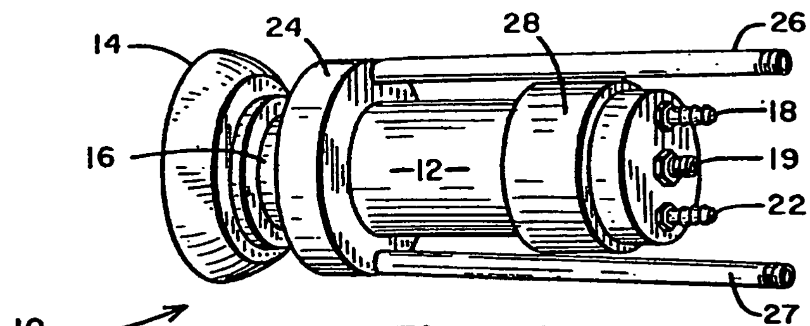

Fig. 1

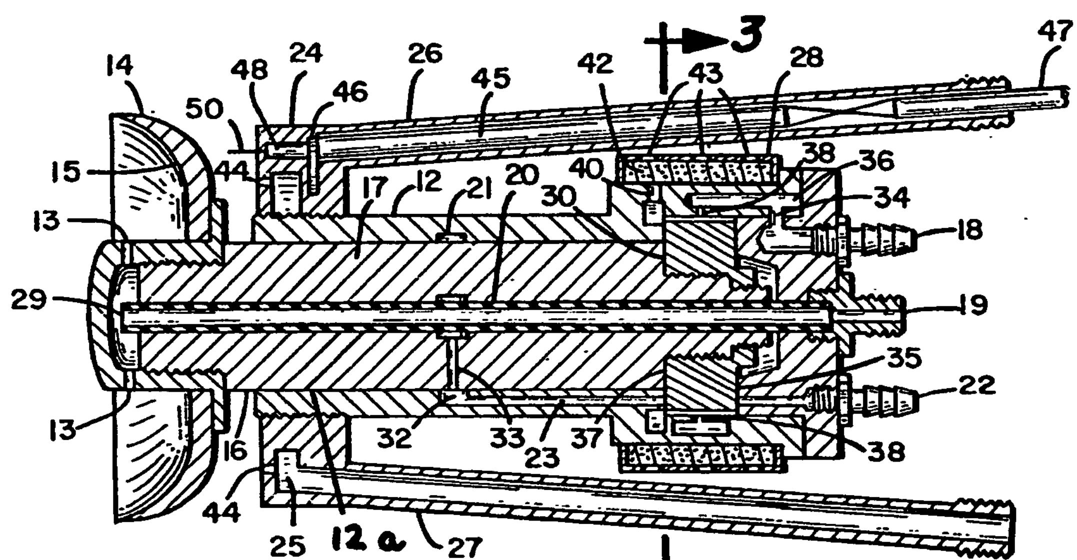

Fig. 2

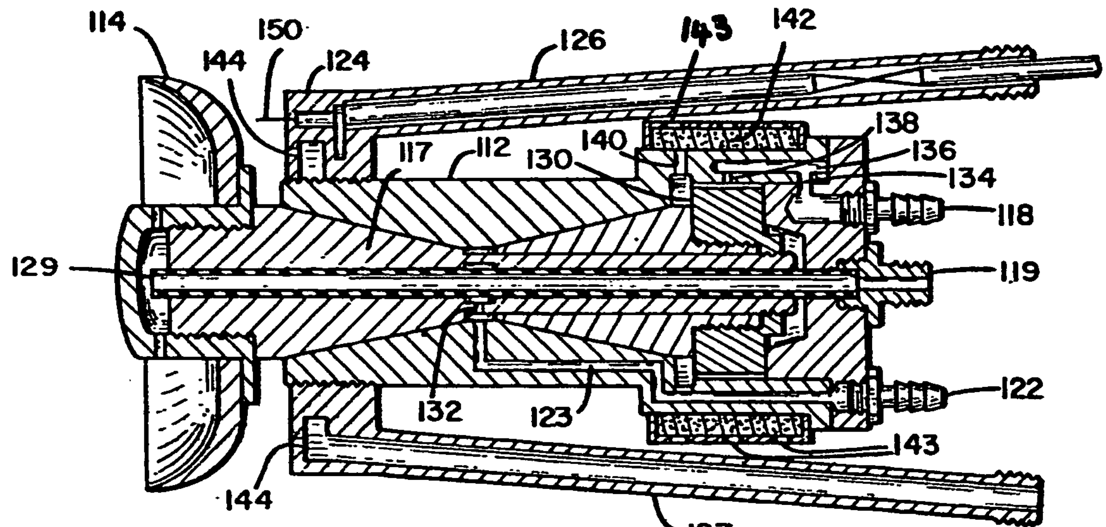

Fig. 4

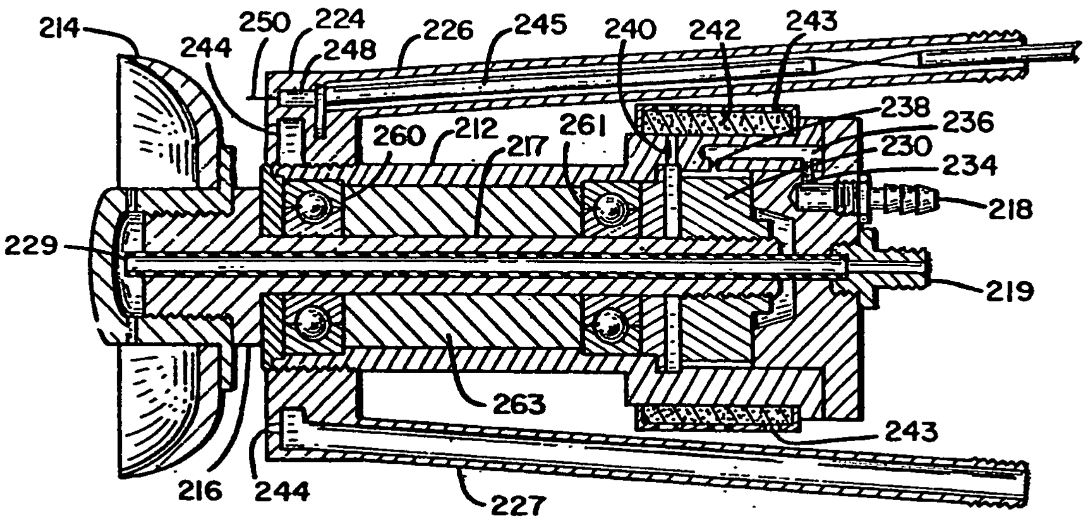

Fig. 5

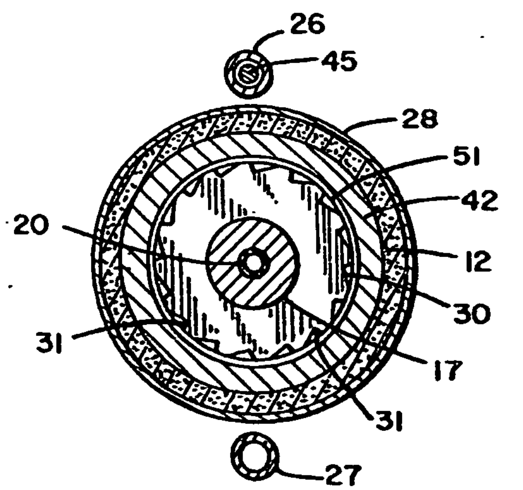

Fig. 3

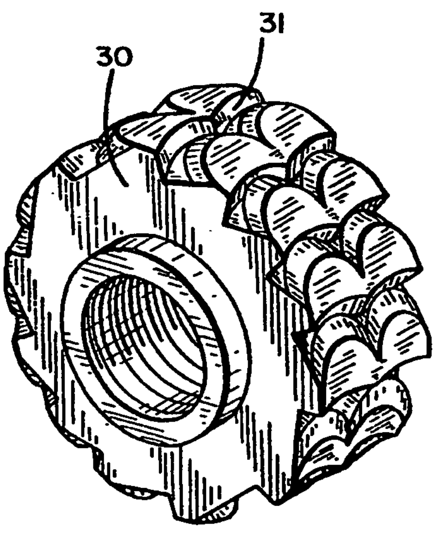

Fig. 6

SPECIFICATION

A rotary spray atomizer

The present invention relates to a rotary spray atomizer for applying paint and other materials in liquid atomized form, and more particularly relates to a rotary atomizer adapted for electrostatic paint spraying.

The use of rotary atomizers for applying paint to coating surfaces has long been known in the art. These devices typically operate by rotating a disc or cup-shaped bell at high speed, and by applying a metered flow of liquid paint to the surface of the disc or bell as it is rotating. Centrifugal forces cause the paint supplied to the surface of the disc or bell to become hurled from its edge in droplets, which droplets are then directed toward a surface to be coated.

Rotary atomizers have also been used in conjunction with electrostatic forces for the application of paint, either by placing the rotary atomizer in a highly charged electrostatic field so as to induce the atomized paint particles to accept electrostatic charges and thereby become attracted to a grounded workpiece, or by directly voltage charging the rotary atomizer and thereby causing the paint droplets to become electrostatically charged as they are emitted from the edge of the rotating disc or bell.

In applications where the atomizer itself is voltage charged, the working voltages are typically in the range of 50-150 kilovolts (kv), and therefore a high degree of care must be taken to protect the charged components properly from inadvertent contact with people or nearby objects. Such systems are typically shielded from any possible contact by means of fences, booths, or other similar shielding constructions.

The hazards of prior art electrostatic rotary atomizers have limited the type and scope of applications in which such systems may be used. For example, such systems can only be used in applications wherein sufficient spatial separation is available to provide for relative isolation of the voltage charged rotary atomizer devices, and where a high degree of control can be maintained over the spacing between the atomizer device and articles moving past the device on a conveyor line. Extreme care is required in order to prevent accidental voltage discharges in solvent or other volatile atmospheres. Since prior art atomizers are constructed of metallic materials, or contain a high percentage of metallic materials in their construction, such atomizers inherently have a high value of electrical capacitance. When charged to the voltages associated normally with electrostatic paint spraying, these atomizers accumulate a very high amount of electrical energy in the form of capacitance stored energy. Therefore, if conditions occur wherein a voltage spark is generated, the capacitive energy stored in the atomizer itself will immediately dissipate through the spark, in sufficient energy quantities so as to cause ignition of volatile solvents and the like.

Some prior art rotary atomizers attempt to minimize this problem by applying a resistive coating to the surface of the atomizer disc or bell. This approach is described in U.S. Patent Specification No. 2,989,241, the substance of which is to incorporate an energy damping resistance between the high capacitance components of the rotary atomizer and the workpiece. This damping resistance effectively absorbs some of the electrical energy which would otherwise be dissipated in the form of a high energy spark, and thereby reduces the hazard of fire and explosion.

Despite the foregoing and other disadvantages which result from the use of prior art rotary atomizers, such devices have found widespread use in industry, for they do produce a finely atomized cloud or spray of paint and, as a result, produce a high quality coating on a workpiece. There is therefore a need to provide a rotary atomizer having the inherent advantages of high quality painting, but without the disadvantages associated with the various hazards.

It has been found that the quality of paint atomization is directly related to the rotational speed of the rotary atomizer, the higher the rotational speed the finer the atomization. Therefore, it is not unusual to find rotary atomizers which rotate in the range of 25,000–75,000 revolutions per minute (RPM), which itself produces additional problems. Conventional bearings are difficult and expensive to design to operate at high rotational speeds, and therefore it has been the practice in the industry to design rotary atomizers having various forms of air bearings to suspend the rotating members. Such air bearings have the advantage of providing long life of the rotating members, and therefore it is desirable to incorporate them into any rotary atomizer structure which is inherently less-hazardous than heretofore known in the art.

The concept of utilizing an energy damping resistance between the capacitance charged components of an atomizer and the workpiece is an advantage which is also well-known in the art, at least in the form described hereinabove. Conventional automatic and manual spray guns utilize this same concept by placement of a physical resistance in a non-conductive spray gun body, which resistance is placed adjacent the front end of the spray gun to accomplish the required electrical resistance damping. This approach in a design of conventional spray guns has greatly reduced the hazards associated with such guns, and it is desirable to incorporate such a concept into a rotary atomizer. However, prior art rotary atomizers which utilized such improvements as air bearing assemblies were required to be constructed of high precision metallic components, and such components inherently prevented the use of non-conductive bodies. It is therefore desirable to combine into a single rotary atomizer structure all of the advantages heretofore known with respect to conventional spray guns, air bearing technology, and rotary atomizer technology, so as to provide a new and improved rotary atomizer having all of the advantages in each field of technology.

According to the present invention, there is provided a rotary spray atomizer adapted to receive a liquid paint or like liquid and to distribute atomized particles of such a liquid under the influence of electrostatic forces, comprising

a) a housing made substantially completely from electrically non-conductive material and having an

interior recess therein;

b) a rotor made substantially completely from electrically non-conductive material and rotatably mounted in said recess,

c) an electrically non-conductive dish-shaped member fixedly attached to said rotor and projecting outside said housing;

d) an electrically non-conductive feed tube for feeding said liquid to a position adjacent the dish-shaped member;

e) an electrically non-conductive turbine member fixedly attached to said rotor and mounted in said housing recess, said turbine member having a plurality of projecting blades thereon;

f) means for applying a high voltage to said liquid; and

g) means for delivering pressurized air against said turbine member blades in said housing, and means for exhausting air from said housing.

Preferably, the feed tube is fixed to the housing and extends through an axial opening in the rotor, the feed tube having a first opening adjacent the dish-shaped member and a second opening disposed outside the housing.

The said housing or means secured thereto may be provided with a plurality of openings in the region adjacent said dish-shaped member, an air passage being coupled to said openings and to a source of pressurized air.

There may be passages in said housing for delivering pressurized air to the region intermediate said rotor and said housing to act as an air bearing.

Alternatively, there may be electrically non-conductive bearings mounted between said rotor and said housing.

Preferably, the said rotor and said housing are constructed of a ceramic material.

The said means for applying a high voltage may comprise one or more conductive electrodes projecting externally of said housing adjacent said dish-shaped member.

There may be means for applying a high voltage to said electrodes which comprise at least one resistance member enclosed in said housing and electrically connected to said electrodes.

There may be means for applying a high voltage to said electrodes which comprise a resistance member electrically connected to each such electrode and a common electrical path connected between all such resistance members and a single source of high voltage.

There may be a plurality of diode-capacitor voltage doubler circuits in series connection in said common electrical path.

In its preferred form, the atomizer of the present invention is constructed virtually entirely of electrically non-conductive material, thereby eliminating capacitive energy storage problems and the inherent hazards which inevitably exist in an electrostatic spray gun having metallic components. The rotor, housing and other non-conductive parts are preferably made from a ceramic material. A high voltage electrical path is provided through the housing, terminating in one or more needle electrodes which project external to the housing in the region adjacent the rotatable dish-shaped member. Further air passages may be provided through the housing to direct a source of pressurized air forwarly past the rotatable dish-shaped member to provide deflection and shaping air for atomized particles which are emitted from the edge of the rotating dish-shaped member.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

Figure 1 shows an isometric view of a first embodiment of a rotary spray atomizer according to the present invention;

Figure 2 shows an elevational cross-sectional view of the embodiment of Figure 1;

Figure 3 shows a cross-sectional view taken along the line 3-3 of Figure 2;

Figure 4 shows a second embodiment of a rotary spray atomizer according to the present invention in cross section;

Figure 5 shows a third embodiment of a rotary spray atomizer according to the present invention in cross section; and

Figure 6 shows an isometric view of a turbine member.

Terms such as "top" and "bottom", as used in the description below, are to be understood to refer to directions as seen in the accompanying drawings.

In Figure 1 there is shown a rotary spray atomizer 10 adapted to receive liquid paints and the like and to distribute atomised particles of such liquids under the influence of electrostatic forces. The atomizer 10 has an outer housing 12 constructed at least substantially completely from electrically non-conductive material. Ceramics are preferred although the housing 12 may be made from materials such as nylon or plastics material. A disc, cup, or dish-shaped bell 14 is fixedly connected to a rotor shaft 16 which projects from the front of housing 12. The bell 14 is made of electrically non-conductive material. The rear of housing 12 has a first air inlet 18 and a second air inlet 22, both of which will be hereinafter described. A liquid inlet 19 is axially positioned relative to the housing 12 and the rotor shaft 16. An outer cover 28 is circumferentially attached to the outside of the housing 12. An annular housing 24 surrounds the housing 12 adjacent its front end, and the housing 12 may be threadably attached to the annular housing 24. An electrically non-conductive tube 26 is connected to the annular housing 24 near its top edge and an electrically non-conductive tube 27 is connected to the annular housing 24 near its bottom edge.

Figure 2 shows an elevational cross-sectional view of the rotary atomizer 10. The shaft 16 is formed on one end of a rotor 17, and both may be formed from a single piece constructed at least substantially completely from electrically non-conductive material. The shaft 16 and the rotor 17 are preferably constructed from a ceramic material, chosen for its general strength and physical stability under widely varying conditions of temperature, humidity, and other environmental effects. The rotor 17 is closely fitted within an opening or interior recess 12*a* in the housing 12, and has an electrically non-conductive turbine 30 constructed proximate its rear end. The turbine 30 has a plurality of circumferential blades 31 (Figure 3) which will be described in more detail hereinafter. The

rotor 17 is concentrically mounted about an electrically non-conductive feed tube 20 which is fixedly attached to the housing 12 and extends through an axial opening in the rotor 17. The feed tube 20 is thus axially positioned relative to the rotor 17 and the housing 12, and has a central opening along its entire length. The rear end 19 of the feed tube 20 constitutes an opening which is adapted for coupling to a source (not shown) of paint or other liquid, which is typically applied to the feed tube 20 under a slight pressure so as to cause a forward feed of the liquid to the front end of the feed tube 20. The rear end 19 is disposed outside the housing 12. The front of the feed tube 20 has an opening 29 adjacent to the bell 14, to permit liquid to be metered therethrough and to flow onto the forward surface 15 of the bell 14 through openings 13. The bell 14 is fixedly attached to the shaft 16 and rotates therewith.

The air inlet 22 is connected to a passage 23 inside the housing 12. The passage 23 communicates with an annular groove 32 about the inner surface of the opening 12*a* in the housing 12, and serves to distribute pressurized air evenly about the rotor 17. Pressurized air from the annular groove 32 is distributed evenly over the clearance region between the rotor 17 and the opening 12*a* in housing 11, the pressurized air flowing between the respective surfaces of the rotor 17 and housing 12 and exhausting at either end of the rotor 17. This air flow serves as an air bearing cushion between the rotating rotor 17 and fixed housing 12, the said cushion permitting free rotation of the rotor 17 about its axis relative to the housing 12.

A further passage 33 passes through the rotor 17 to an annular groove 21 about the feed tube 20. The pressurized air which is fed into the annular groove 21 serves a similar purpose to that supplied to the annular groove 32; namely, to provide a flow of air between the rotor 27 and the feed tube 20 so as to act as an air bearing. In the preferred embodiment, the gap between the inner opening of the rotor 17 and the feed tube 20 may be larger than the gap between the rotor 17 and the housing 12. Pressurized air distributed *via* the annular groove 21 is also provided for the purpose of maintaining a positive pressure about the feed tube 20, thereby to purge foreign materials from accumulating within this region.

An air bearing surface is also created about the turbine member 30, by virtue of the air flow paths described herein. The outer edge 35 of the turbine 30 receives pressurized air from the inlet 22, and this pressurized air creates an air cushion film between the turbine member 30 and the housing 12. Likewise, an air cushion film is maintained between the inner edge 37 of the turbine 30 and the housing 12, so that the edges 35 and 37 serve as parts of a thrust bearing to contain the forward and rearward movement of the rotor 17 within the housing 12.

The air inlet 18 is coupled to a passage 34 in the housing 12, and the passage 34 communicates with a turbine chamber 36. The turbine chamber 36 is an annular chamber extending about the turbine 30 to provide a source of pressurized air for driving the turbine 30 in a rotating direction. A plurality of nozzles 38 are directed toward the blades 31 on the turbine 30, and communicate with the turbine chamber 36. The nozzles 38 provide a plurality of air jets for injecting pressurized air against the turbine blades 31 and thereby to rotate the turbine 30. The turbine 30 is fixedly attached to the rotor 17, and the rotor 17 therefore rotates with the turbine 30. One or more exhaust ports 40 open into the region surrounding the turbine 30, and serve to exhaust pressurized air from the turbine 30 into a muffler chamber 42. The muffler chamber 42 extends annularly about the exterior surface of the housing 12, and may be filled with a sound insulating material to diminish the exhaust noise of pressurized air escaping from the muffler. A plurality of exterior openings 43 are drilled through the exterior wall of the muffler chamber 42 in order to exhaust the air therein into the atmosphere.

The annular housing 24 is either formed as a part of the housing 12 or is fixedly attached about the housing 12, adjacent the front end of the housing 12. The annular housing 24 is connected to the non-conductive tube 27 which acts as an air passage, and the tube 27 is adapted for connection to a further source (not shown) of pressurized air. The housing 24 has an annular internal passage 25, and a plurality of air jet openings 44 extend about the housing 24 in air flow contact with the passage 25. The air jet openings 44, which are disposed adjacent the bell 14, are forwardly directed, and may be as many in number as thirty to ninety, and serve to provide a forwardly directed plurality of jets of air for shaping an atomised paint pattern as it develops from the bell 14.

The annular housing 24 also has connected thereto the non-conductive tube 26. The non-conductive tube 26 contains electrical circuits for electrostaticallly energizing the rotary spray atomizer. The rear end of the non-conductive tube 26 is adapted for connection to an electrical cable 47, which cable may provide high voltage to the rotary spray atomizer. A large resistor 45 is located inside the tube 26, the resistor 45 serving the function of damping out any capacitively stored energy which may exist in the supply cable 47. The resistor 45 is conductively coupled to an electrical contact 46 in the housing 24. The contact 46 may extend annularly about the housing 24, or it may be a single contact point, depending upon the particular design desired for the apparatus. A smaller resistor 48, which is enclosed in the housing 24, is conductively coupled to the contact 46, and the forward end of the resistor 48 is connected to an electrode 50 which projects externally of the housing 12 adjacent the bell 14. The electrode 50 projects forwardly to serve as a source of electrostatic energy for accomplishing electrostatic paint distribution. It should be appreciated that a plurality of electrodes 50 may be arranged about the housing 24, if more than one electrode discharge point is desired. For example, in the preferred embodiment of the present invention it has been found to operate satisfactorily with four electrodes 50 positioned at approximately 90° angles about the housing 24. In this case, the contact 46 is extended about the interior of the housing 24, and an individual resistor 48 is provided between the contact 46 and the respective electrode 50 at each of the four connection points.

Figure 3 shows a cross-sectional view taken along the line 3-3 of Figure 2, wherein the structure of the

turbine assembly may be noted. The turbine blades 31 are distributed equally about the outer surface of the turbine 30. The turbine blades 31 are shaped so as to provide a maximum effective area for receiving pressurized air from the nozzles 38. As air is used to cause rotational motion of the turbine 30, it develops a positive pressure in the region around the turbine 30 and must be exhausted into muffler chamber 42, and thereafter to the atmosphere. In addition, the pressurized air used as an air bearing cushion 51 between the rotor 17 and the housing 12 is also exhausted into the atmosphere *via* the same path as the air supplied to the turbine 30.

Figure 4 shows a second embodiment of a rotary spray atomizer according to the invention in cross-section. This embodiment functions generally the same as the embodiment shown in Figure 2, although certain constructional differences are present. For this reason, the Figure 4 construction will not be described in detail, parts of the Figure 4 construction corresponding to those of Figure 2 having corresponding reference numerals to which 100 has been added. A significant constructional difference is related to the use of a rotor 117, and in particular its air bearing system relative to a housing 112. The rotor 117 is formed of two generally cone-shaped sections, having a narrowed centre portion and extending to larger diameter end portions. Pressurized air entering an air inlet port 122 is coupled through a passage 123 to an annular chamber 132. The chamber 132 provides a source of pressurized air for uniformly distributing air over the external surface of the rotor 117 in both directions from its narrowed centre region. This film of air is caused to flow outwardly toward both ends from the centre and serves to provide an air bearing cushion for the rotor 117. The inherent design of the rotor 117 as shown in Figure 4 eliminates the need for a thrust bearing in the apparatus, since axial thrust forces are inherently balanced by the shape of the rotor 117.

Pressurized air is provided at an inlet port 118, and fed through a passage 134 to a turbine chamber 136. From the turbine chamber 136 the pressurized air passes through a plurality of nozzles 138 which inject the air against the surfaces of blades on a turbine 130. This pressurized air causes the turbine 130 to rotate, and thereby causes the rotor 117 to rotate therewith, generating the necessary rotational motion for the apparatus. Exhaust air is collected and routed out of the turbine region *via* exhaust ports 140 into a muffler chamber 142. From the muffler chamber 142 the air is exhausted into the atmosphere through openings 143.

The functions of a non-conductive tube 127, an annular housing 124, and a non-conductive tube 126 are essentially similar to the corresponding positioned elements described with reference to Figure 2. For example, a plurality of forwardly directed air jets 144 may be provided in the annular housing 124 for the purpose of shaping and assisting in the control of the atomization pattern from a bell 114. Likewise, a plurality of electrodes 150 may be arranged about the forward surface of the annular housing 124 to provide the necessary electrostatic voltages for the electrostatic operation.

As an alternative embodiment to the electrical circuit described herein, it is contemplated that a cascade voltage multiplier circuit, which may be constituted by a plurality of diode-capacitor voltage doubler circuits in series, may be enclosed within a conductive tube 126 or equivalent, and may thereby provide high voltage multiplication directly within the apparatus itself. In this case, the high voltage multiplier circuit need only have supplied to it a relatively low input voltage, the cascade multiplier providing the necessary voltage magnification for driving the electrode 150 or equivalent. The design of appropriate cascade multiplier circuits is well-known in the art, and technology in recent years has enabled the design of such devices to be accomplished within a relatively small volume, which volume would be suitable for operation with the atomizer of the present invention.

Figure 5 shows a further alternative embodiment of the present invention. The construction and operation of the Figure 5 embodiment is generally similar to that of Figure 2 and will therefore not be described in detail, parts of the Figure 5 construction corresponding to those of Figure 2 havving corresponding reference numerals to which 200 has been added. An electrically non-conductive housing 212 surrounds a rotatable rotor 217, and the rotor 217 is contained by electrically non-conductive ball bearings 260 and 261 which support the rotor 217 and permit rotation thereof relative to the housing 212. The bearings 260, 261 are mounted between the rotor 217 and the housing 212. The rotor 217, which is constructed from electrically non-conductive material, terminates at its forward end in a projecting shaft section 216. The shaft section 216 is threadably attached to a bell or disc 214 as has been described hereinbefore. An annular electrically non-conductive housing 224 is threadably attached adjacent the forward end of the housing 212, and the annular housing 224 supports the electrical components including one or more electrodes 250, resistors 248, and electrical circuits 245. The annular housing 224 also includes a plurality of air jets 244 which are forwardly projecting to direct the pattern of spray particles emitted from the bell 214. A turbine member 230 is fixedly attached to the rotor 217, for rotation therewith, and pressurized air is deflected to rotate the turbine member 230 *via* nozzles 238. The nozzles 238 are in flow communication with a turbine chamber 236, which in turn is coupled *via* a passage 234 to an air inlet 218. The pressurized air is exhausted from the device *via* an exhaust port 240 and into the atmosphere *via* openings 243. An electrically non-conductive spacer 263 is inserted between the bearings 260 and 261, to position and hold the bearings in place.

Figure 6 shows an isometric view of the turbine member 30, or the other similar turbine members described herein. The turbine blades 31 of the turbine member 30 are curved so as to receive pressurized air adjacent the centre of the turbine member, and to deflect the air outwardly to both sides as the air is used to rotate the turbine member. The exhaust air is deflected outwardly along either turbine edge, and is conveyed to the atmosphere as has been described hereinbefore.

It should be noted that all of the components illustrated in the figures are constructed from electri-

cally non-conductive materials, with the exception of certain electrical connections. Because of the almost exclusive use of non-conductive materials there is no capacitive energy storage caused by the accumulation of voltage charges on metallic members, and therefore there is no possibility for a spark discharge to occur from this device as a result of excess capacitive energy. Therefore the use of non-conductive materials provides for an almost completely safe apparatus, and the further use of suitably sized resistors as shown in the figures provides an additional margin of safety. The only capacitively stored energy which may be identified in connection with the atomizer of the invention would be that energy stored in the voltage delivery cables, and the use of resistors downstream from these voltage cables suitably protects against excessive discharge currents.

It should also be appreciated that it is possible to use independently controlled air pressure sources for driving the respective air inlets shown and described herein. For example, the pressurized air used to provide the air bearing cushion for the turbine rotor may be provided from a different air pressure regulator than the pressurized air used to drive the turbines. Likewise, the pressurized air for use in shaping the atomised pattern may be independently controllable.

In operation, the apparatus is placed in proximity to a painting zone, preferably adjacent a conveyor line adapted for conveying articles to be coated. The respective air pressures are adjusted to provide an optimum atomization pattern from the rotating bell, which may occur at rotational speeds in the range of 20,000–80,000 revolutions per minute (RPM). The pressurized air utilized to drive the turbine and the pressurized air utilized to provide the air bearing cushion may be balanced for optimum operation of the rotor at the desired RPM. Likewise, the pressurized air utilized to provide air shaping may be set to provide the desired amount of control over the atomized pattern, consistent with the liquid delivery rate into the apparatus. The high voltage circuits may be adjusted to provide electrostatic forces suitable for optimum paint spraying and all of these parameters may be adjusted to optimize the overall operating conditions. The apparatus may be used in conjunction with other similar devices in an automatic painting system, wherein atomizers are controllable in synchronization with articles conveyed along a conveyor line to provide a wide coating area. In this manner, large articles such as automobile bodies may be effectively coated without danger of electrical discharge.

In the preferred embodiment, the rotor, shaft and housing are made of Diamonite P-3142-1, a ceramic made by Diamonite Products, Dewy and Almy Chemical Division, W.R. Grace & Co. This material is 95% Al_2O_3 and has the following properties:

Tensile Strength 28,500 psi (2,003,750 g/cm^2)

Compression Strength 350,000 psi (24,607,450 g/cm^2)

Modulus of Elasticity 46.09 × 10^6 psi (3240 × 10^6 g/cm^2)

Dielectric Strength 230 v/mil 1/4" (6.4 mm) thick.

The diametral clearance between the rotor and housing is desirably about .001 inch (0.025 mm) which decreases to about .0006–.0008 inch (0.015–0.02 mm) during operation.

CLAIMS

1. A rotory spray atomizer adapted to receive a liquid paint or like liquid and to distribute atomized particles of such a liquid under the influence of electrostatic forces, comprising

a) a housing made substantially completely from electrically non-conductive material and having an interior recess therein:

b) a rotor made substantially completely from electrically non-conductive material and rotatably mounted in said recess,

c) an electrically non-conductive dish-shaped member fixedly attached to said rotor and projecting outside said housing;

d) an electrically non-conductive feed tube for feeding said liquid to a position adjacent the dish-shaped member,

e) an electrically non-conductive turbine member fixedly attached to said rotor and mounted in said housing recess, said turbine member having a plurality of projecting blades thereon;

f) means for applying a high voltage to said liquid;

g) means for delivering pressurized air against said turbine member blades in said housing, and means for exhausting air from said housing.

2. An atomizer as claimed in claim 1 in which the feed tube is fixed to the housing and extends through an axial opening in the rotor, the feed tube having a first opening adjacent the dish-shaped member and a second opening disposed outside the housing.

3. An atomizer as claimed in claim 1 or 2 in which the said housing or means secured thereto are provided with a plurality of openings in the region adjacent said dish-shaped member, an air passage being coupled to said openings and to a source of pressurized air.

4. An atomizer as claimed in any preceding claim comprising passages in said housing for delivering pressurized air to the region intermediate said rotor and said housing to act as an air bearing.

5. An atomizer as claimed in any of claims 1-3 comprising electrically non-conductive bearings mounted between said rotor and said housing.

6. An atomizer as claimed in any preceding claim in which said rotor and said housing are constructed of a ceramic material.

7. An atomizer as claimed in any preceding claim wherein said means for applying a high voltage comprises one or more conductive electrodes projecting externally of said housing adjacent said dish-shaped member.

8. An atomizer as claimed in claim 7 wherein there are means for applying a high voltage to said electrodes which comprise at least one resistance member enclosed in said housing and electrically connected to said electrodes.

9. An atomizer as claimed in claim 7, wherein there are means for applying a high voltage to said electrodes which comprise a resistance member electrically connected to each such electrode and a common electrical path connected between all such resistance members and a single source of high voltage.

10. An atomizer as claimed in claim 9 comprising a plurality of diode-capacitor voltage doubler circuits in series connection in said common electrical path.

11. A rotary spray atomizer substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

12. Any novel integer or step or combination of integers or steps, hereinbefore described, irrespective of whether the particular claim is within the scope of, or relates to the same or a different invention from that of, the preceding claims.

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